Bio-regenerative Solar cells: a sustainable source of energy

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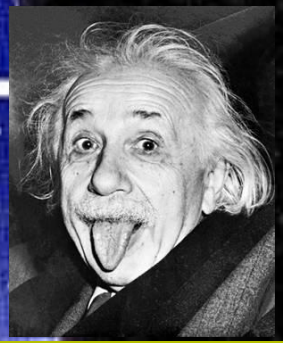
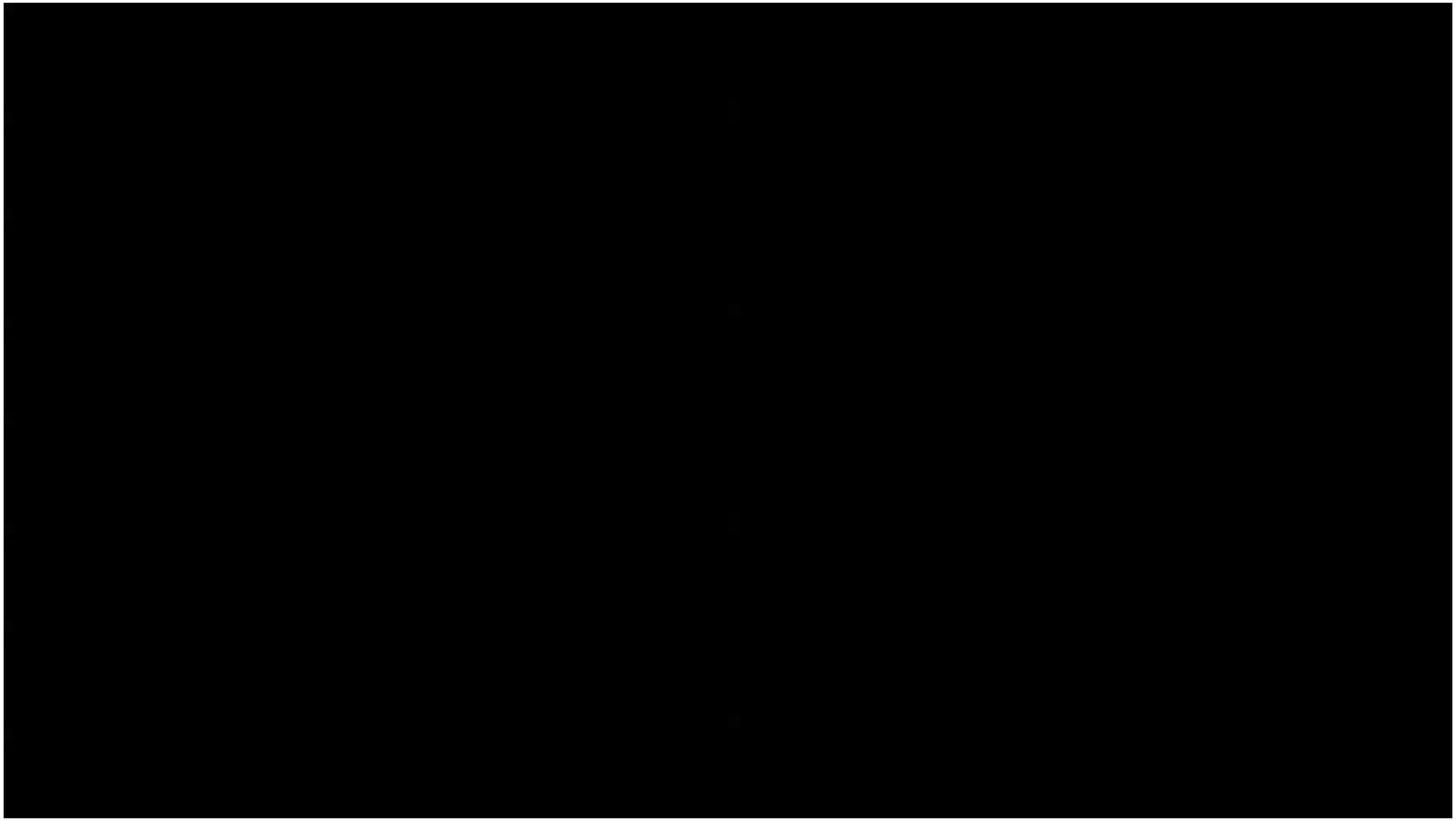
A brief history of Solar Cells

- The photovoltaic effect is the creation of voltage or electric current in a material upon exposure to light.
- The photovoltaic effect was first experimentally demonstrated by French physicist A. E. Becquerel, in 1839.
- Albert Einstein explained the underlying mechanism of the photoelectric effect in 1905, for which he received the Nobel prize in Physics.
- Solar cells were first suggested to be added to a satellite in 1958, proved to be a huge success, and were quickly designed into many new satellites.
- Widespread use in space applications where their power-to-weight ratio was higher than any competing technology.
- Building bio-regenerative solar panels for harnessing energy for deep space research instrumentation is one of the goals being pursued by space research agencies worldwide, mostly for efficiency.



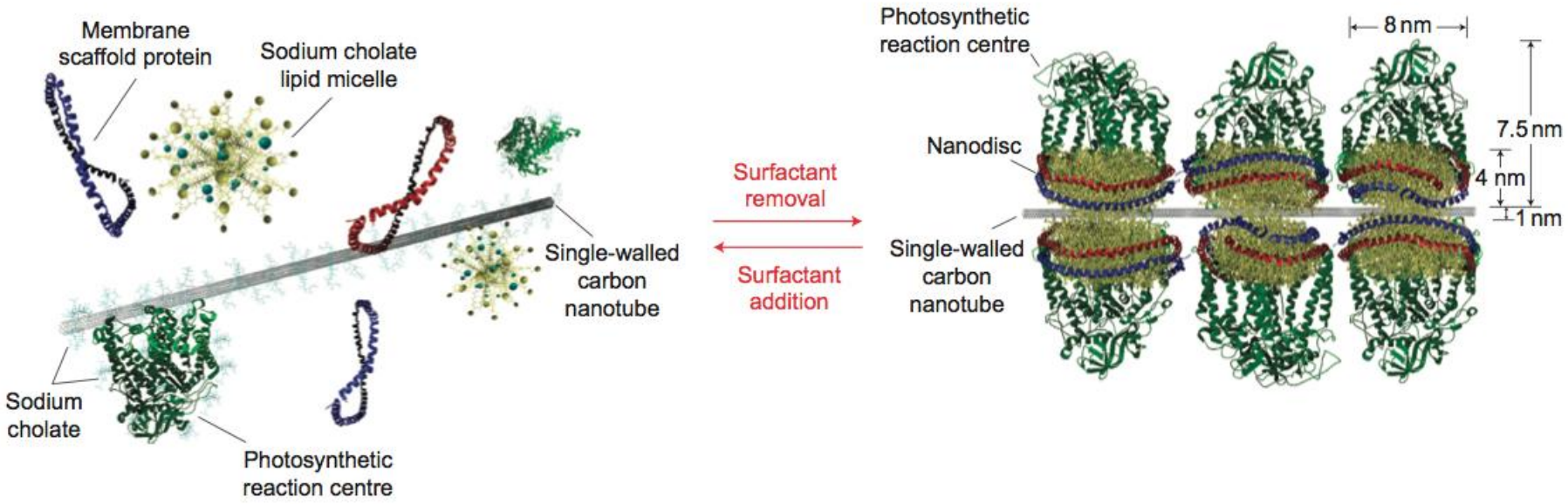
Importance of bio solar cells



http://www.youtube.com/watch?feature=player_embedded&v=EeRSQUw4qp4

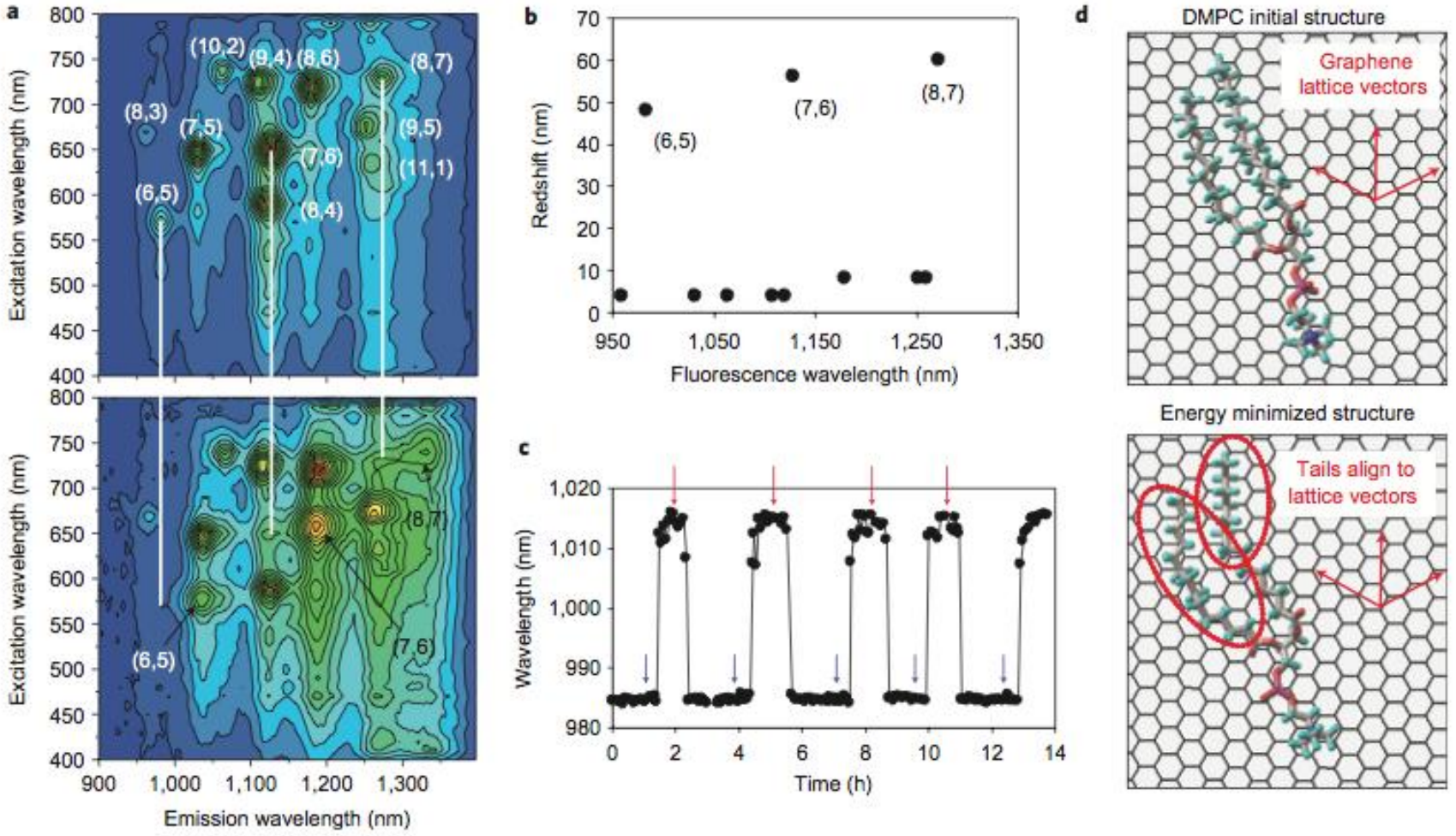
Reference: http://web.mit.edu/newsoffice/2012/biosolar-0203.html

Reference Model

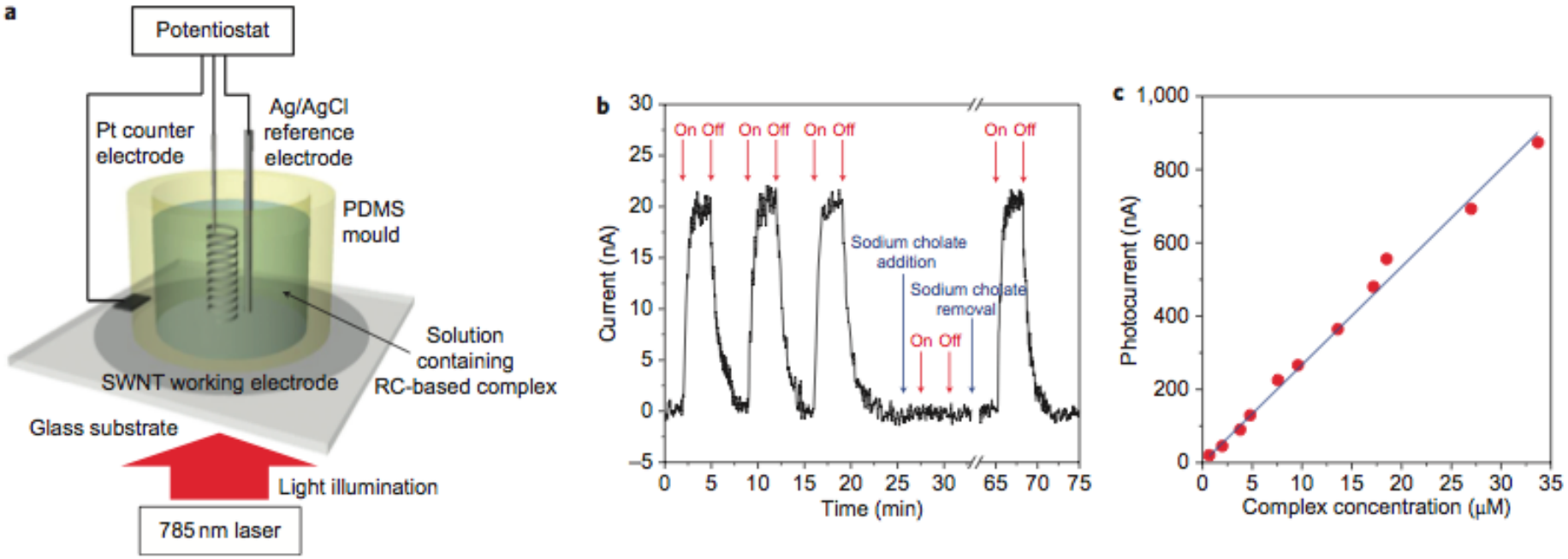


- Synthetic complex mimicking self-repair mechanism of photosynthesizing organisms

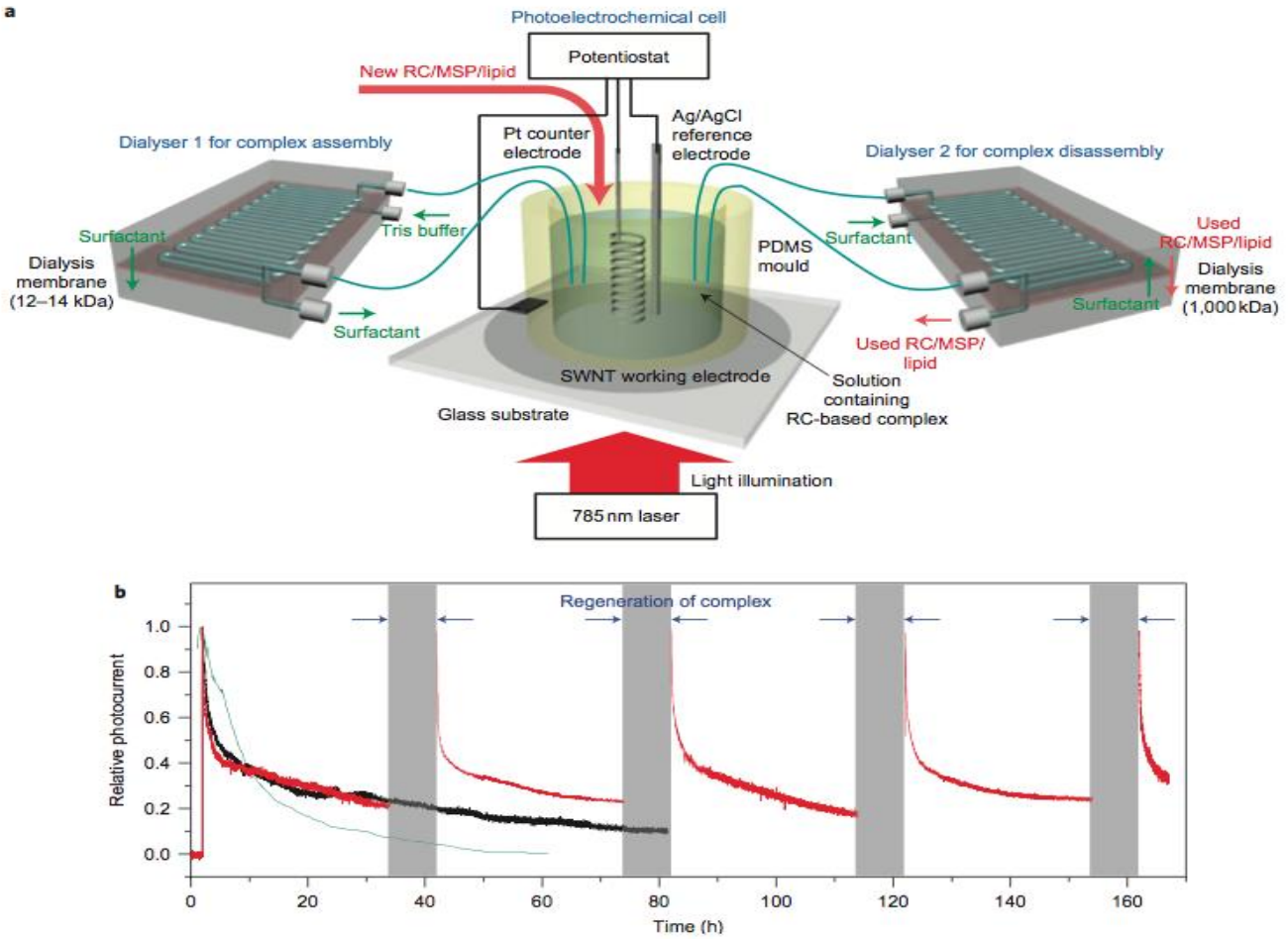
- System disassembles upon the addition of a surfactant and reassembles upon its removal over an indefinite number of cycles



Optical signatures of the assembled RC–ND–SWNT complex



Photoelectrochemical activity of an assembled RC–ND–SWNT complex in a photoelectrochemical cell.



Photoelectrochemical activity of a RC–ND–SWNT complex that autonomously regenerates.

a, Schematic of the photoelectrochemical system, which comprises a photoelectrochemical cell incorporating two recirculating membrane dialyzers.

b. Temporal photoresponse of the RC–ND–SWNT with and without regeneration. Without regeneration (black curve), the photocurrent decreases sharply, falling to 50% after 5 h and 10% after 80 h. Deactivation is comparable to dye-sensitized solar cell (DSSC) data published in the literature (green curve)

Key Points to remember

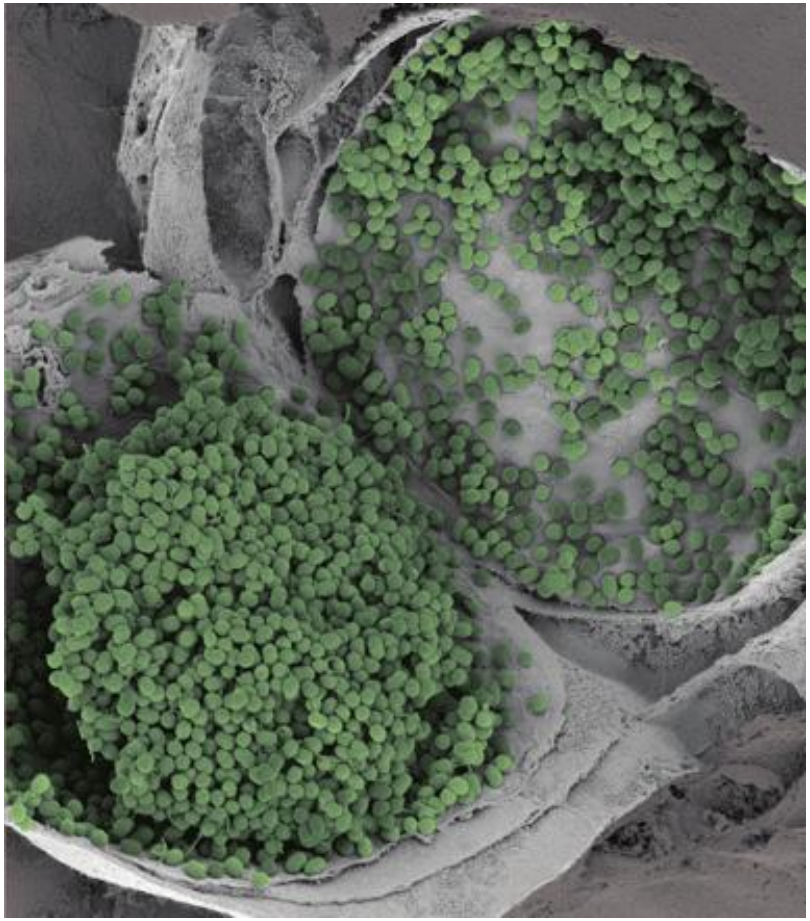
- Thermodynamically metastable and can only transition reversibly if the rate of surfactant removal exceeds a threshold value.

- Increased photoconversion efficiency of more than 300% over 168 hours and an indefinite extension of the system lifetime was observed.

- Limited by frequency of regeneration steps and cycle, which can be overcome with more efficient dialyzers and mass transfer (akin to Microfluidic platform)

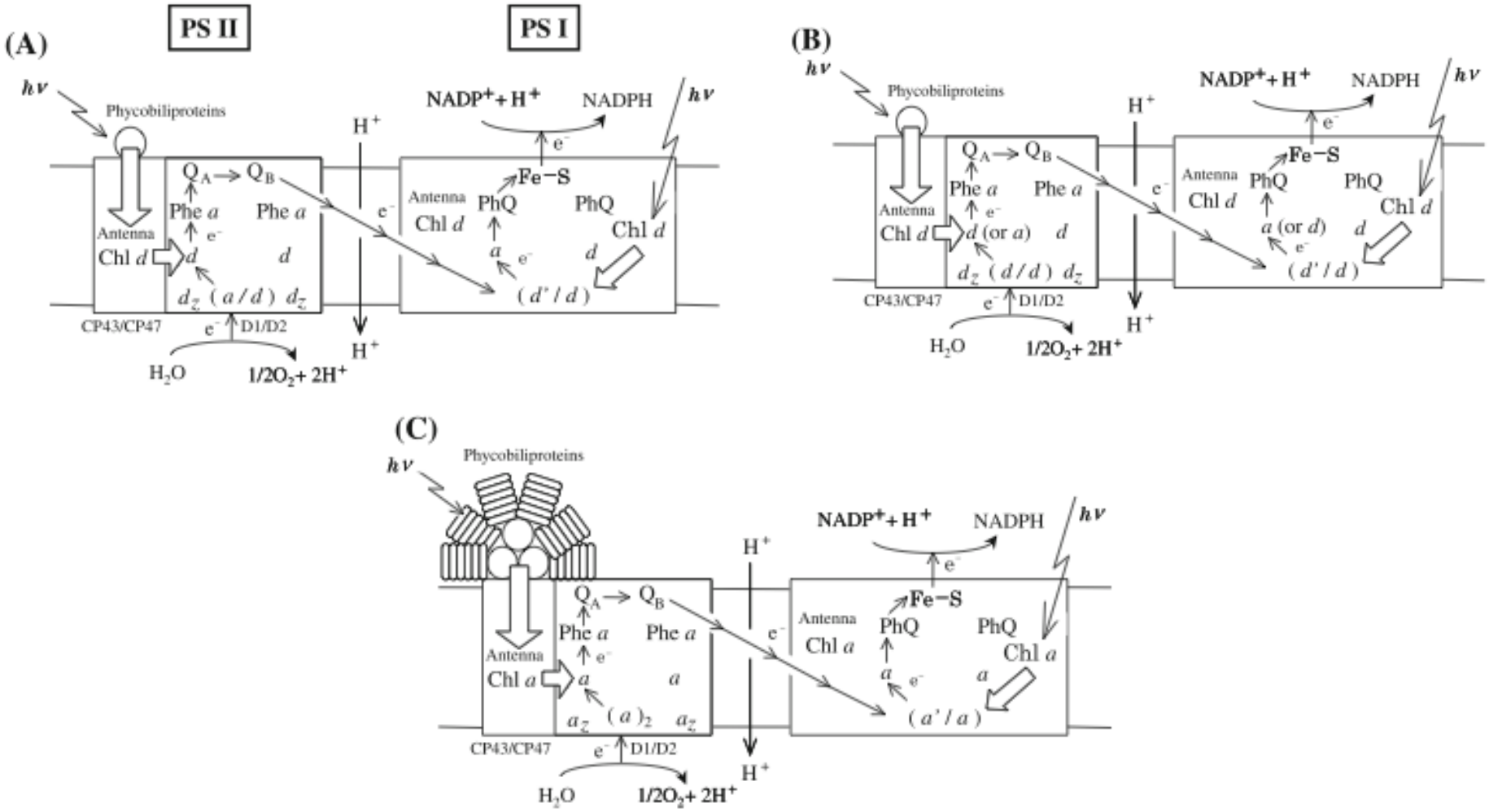
Proposed Model

For Deep Space and Terrestrial areas with scarcity of sunlight

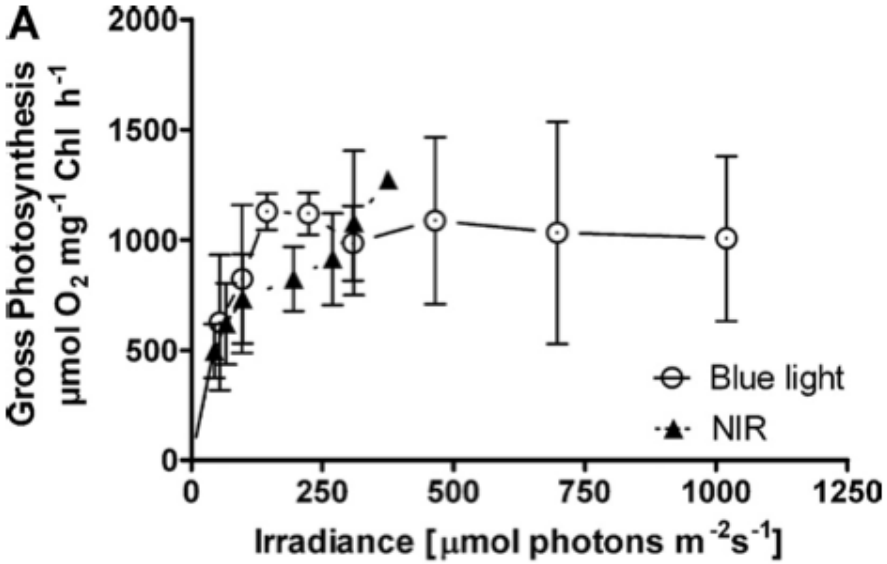


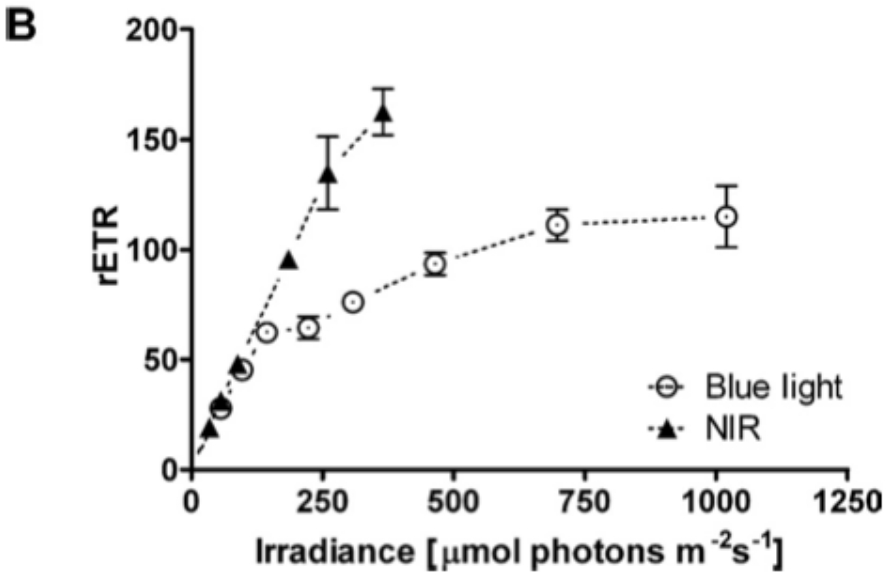
Properties of A. marina

- Cyanobacteria, photosynthesizing pigment of CP43 family of proteins have a similar photosystem 2 like that of purple bacteria
- Unique photosystem, chlorophyll-d dominates 99% of cellular chlorophyll
- The energy storage efficiency of the photosynthetic light reactions in *A. marina* is comparable to or higher than that of typical Chl a-utilizing oxygenic phototrophs.
- Higher photosynthetic efficiencies under low-light conditions



Models for pigment arrangement in photosystems of (A, B) A. marina and (C) typical cyanobacteria





A. Gross photosynthesis arrangement in photosystems measured with oxygen micro sensor

B. Relative electron transport rates measured on bead surface

Therefore..

For the photoelectrochemical conversion protein, using the chlorophyll-d producing cyanobacteria *Acaryochloris marina* that show the ability to thrive in extreme shade or less availability of light and also adapt to strong light, are well adapted to oxygen conditions ranging from anoxia to hyperoxia

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